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SELECTIONS

From The Youth's Companion.

CONTENTS.

PERRY MASON & COMPANY,

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Niagara. – The American Side.

Harnessing Niagara.

If you imagine a line of very strong horses, harnessed tandem, extending eight hundred and fifty miles, from Boston almost to Chicago, all pulling steadily, you will get some idea of the amount of power which it is expected will be taken from Niagara Falls by water-wheels, and distributed chiefly in the form of electricity.

Between three and four million dollars have been spent in digging the tunnel and wheel-pit from which the first instalment of the power is supplied, and much more money will be used to develop the full four hundred and fifty thousand horse-power for which the plans provide.

No one can tell at present just how far this enormous force will be sent; but some of the best engineers believe that it will be made to turn mill-wheels, light streets and even light and heat houses throughout the greater part of New York State, a large territory in Canada, and perhaps here and there in neighboring states.

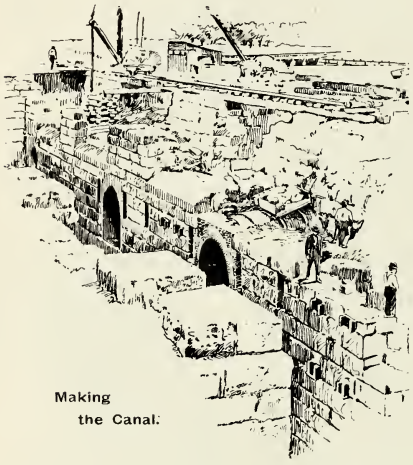
Yet the great cataract will not be robbed of much of its strength; for it is estimated that the horse-power of Niagara Falls is nearly five million, nine hundred thousand—the greatest that nature has concentrated at any one place on the globe except, possibly, the yet unmeasured Victoria Falls of the Zambesi. It has been said that all the coal mined in the world would barely supply the steam-pumps which would be needed to pump back the water that flows over the Falls.

When the water required to create four hundred and fifty thousand horse-power is drawn from the river above the Falls and sent to the gorge below by a short cut through tunnels, the great cataract will be lowered about seven inches only, and the loss will hardly be noticed.

Plans for using Niagara Falls to run machinery had been considered for half a century, but it was not until 1886 that the

necessary permission to use Niagara water was asked and obtained from the New York Legislature. Four years later money for the undertaking had been supplied by capitalists and banking houses.

An International Niagara Commission, under the presidency of Sir William Thomson, of England, now Lord Kelvin, was formed to invite the leading engineers of Europe and America to submit plans for harnessing the cataract without marring its beauty.



Making the Canal.

Twenty-six plans were submitted, and from these the company's engineers devised the designs finally adopted.

On October 4, 1890, the first spadeful of earth was dug, and from that time the work was hurried with all possible speed. Told in the simplest way, the undertaking consists of a number of deep holes in the ground, one much larger than the rest, each with water-wheels at the bottom. The water from the Niagara River is carried to these pits by a canal, led down to the wheels in pipes and then off to the lower river through a tunnel which connects all the pits.

All who have visited Niagara will remember that the river turns almost at a right angle at the Falls. The tunnel, stretching from a point near the river a mile and a half up-stream from the American Fall to a point about one thousand feet below the American Fall, forms, roughly, the hypothenuse of a right-angled triangle, the Falls being at the right angle.

The canal through which water from Niagara flows to the

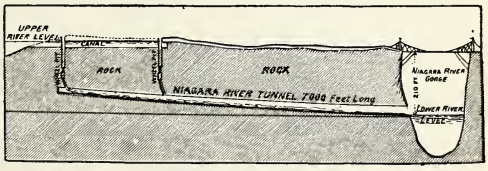
tunnel leads in from the river about two thousand feet. Along the sides are a score of inlets controlled by massive gates. Ten inlets open through the thick masonry which lines the main wheel-pit, and each leads into a steel pipe called a penstock, about as large around as an ordinary street-car.

The penstocks run straight down one hundred and forty feet and discharge into a turbine, consisting of a pair of water-wheels, whose shaft extends upward beside the penstock into the power-house built directly over the pit.

When one of the gates is raised by a delicate electrical apparatus which controls it, water from the canal pours in and flows down the penstock, or water-pipe, pressing into the turbine with a force of five thousand horse-power. After passing through the wheels the water travels on from a discharge tunnel at the end of the wheel-pit out into the main tunnel.

The largest pit, which was completed on the first day of January, 1894, is one hundred and seventy-eight feet deep, twenty-one feet wide, and one hundred and forty feet long. At present there is room for only four penstocks.

It is not easy to imagine a hole pulled up out of the ground, but the masonry that lines this wheel-pit is so thick and strong that if the pit could be pulled up, its walls probably would stand firm like a giant chimney. The chief interest lies in this main wheel-pit, for it is here that electricity is to be generated for distribution throughout the neighboring country.



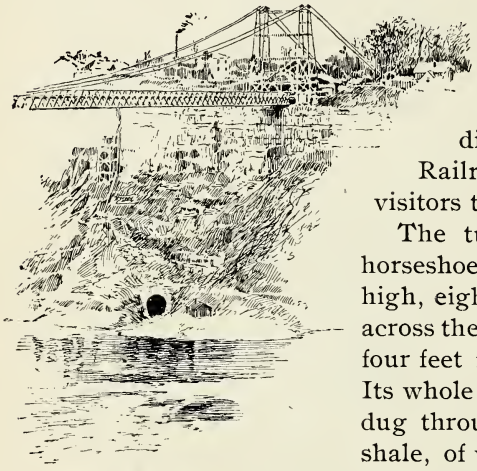
Profile of the Tunnel.

The smaller pits are to supply water-power direct to the various mills that will cluster around the inlet canal. The turbines at the bottom of one of these smaller pits are now turning the wheels of the largest paper-mill in the world.

The tunnel itself simply carries off the water that has done its appointed work. Yet its construction has been the most

difficult part of the whole undertaking, keeping many hundred men busy more than two years, costing in round numbers a million and a quarter dollars; and worse yet, costing twenty-seven lives, through various accidents.

The tunnel slopes gently down from the bottom of the wheel-pit to the portal, just beyond the new suspension bridge, a mile and a third distant, passing beneath the busiest part of the city of Niagara Falls and almost directly under the Central Railroad Station, where most visitors to the Falls alight.



The Outlet.

The tunnel is shaped like a horseshoe; it is twenty-one feet high, eighteen feet and ten inches across the broadest part and nearly four feet narrower at the bottom. Its whole length was blasted and dug through limestone rock and shale, of which enough was taken out to make twenty acres of valuable real estate, when dumped along the shore of the river. This rocky river-bed, two hundred feet underground, is lined with from four to six rings of brick especially prepared to resist wear and tear by the water.

The outlet from which the water flows into the river looks from above like a commonplace black hole down by the water's edge. Yet it is said to be one of the most solid pieces of masonry ever built. It rests on a ledge of sandstone forty feet below the level of the river, and is built up as strongly as steel and stone and cement can make it.

It is well that it should be strong, for it must withstand for many years to come the action of the current without, which boils and foams as it swirls down from the rocks below the

Falls, as well as the tearing rush of the waters within, which pour down a steep incline at the end of the tunnel.

The shaft from each turbine down in the main wheel-pit extends up through the floor of the power-house, to connect with the revolving part of a dynamo capable of converting five thousand horse-power into electricity, which can be sent easily over wires for many miles in any direction, and at the end of its journey can be changed back into the original form of power.

The process is a good deal like sending money by mail. Silver dollars could not be carried easily in a letter, but they may be exchanged for a money-order which, at the end of its journey, can be changed back into silver dollars.

Each dynamo has its own water-gate, water-pipe, water-wheel and shaft, forming practically separate and independent power-plants good for five thousand horse-power each. For a short distance, at least, the electric current is to be sent out on underground wires carried in a subway big enough to walk through without stooping.

Electrical Subway, showing brackets on which the wires will be carried

When it is sent to greater distances, however, it probably will be carried on poles, like the trolley wires for electric street-cars.

As the use of electricity could not be very great at first, the wheel-pit was completed to turn four turbines capable of producing twenty thousand horse-power. As more power is needed the extension of the wheel-pit will make room for six more turbines, until fifty thousand horse-power can be generated there, and the tunnel is filled to half its

capacity. The other half is needed for the smaller water-power pits that will empty into it.

The company has secured the right to dig another tunnel of the same size as the present one, and with wheel-pits to match.

Beside this, practically the same company has bought permission from the Canadian government to dig two wheel-pits and tunnels on the Canada side, solely for the generation of electricity. The plan is to build the first of these wheel-pits and the power-house to match close to the brink of the Horseshoe Fall, at the foot of the high bank directly underneath the Falls View Station. The tunnel will slope down from the bottom of the pit four hundred feet to the river below the fall.

Each of the Canadian tunnels is to carry away the water needed to generate one hundred and twenty-five thousand horse-power. The total capacity of the plants to be built on both sides of the river will be, therefore, four hundred and fifty thousand horse-power.

The chief uncertainty about electricity is that it seems to leak from the wires. The longer the journey it makes the more of it is lost by the way, and consequently the more it will cost. The expense of sending it by wire or subway is also heavy. A great deal depends on this question of price. How far can electricity be sent without a loss that will make its cost equal to steam-power? Upon that question depends whether Niagara's power shall be used only near by the great cataract, or whether it shall be sent broadcast. Inventions have been made recently which, it is believed, will make it possible to carry electricity a great distance without a loss large enough to make its cost equal that of coal.

Nikola Tesla, the brilliant young electrician who astonished scientists by proving that an electrical current can be created which will pass through the upper air without wires to conduct it, says, "The current from Niagara Falls can be taken as far as New York city without great loss, and I believe that before long we shall be able to take it any distance."

CURTIS BROWN.

The St. Clair Tunnel.

No other profession is so much like war as civil engineering. The chief engineer, like the general, must make his plans with the greatest patience and care. He must know the exact facts and guess at nothing. When he cannot avoid guessing, he must weigh all the chances with careful judgment; and when he has done his best he may meet sudden and unlooked-for emergencies, in which all his care will not save his work from ruin.

Of all engineering work that which is least certain is driving tunnels under rivers or other bodies of water. Usually the tunnel must be driven in clay or river silt or sand and gravel, with more or less loose rock and boulders. The trouble is to keep a tight roof, and, if the material is very soft, to keep the tunnel itself in shape.

The St. Clair Tunnel is one of the most remarkable in the world. The tunnel is six thousand feet long, about a mile and one-seventh. Including the open cuttings on each end, the excavation extends eleven thousand six hundred feet, about two miles and one-fifth.

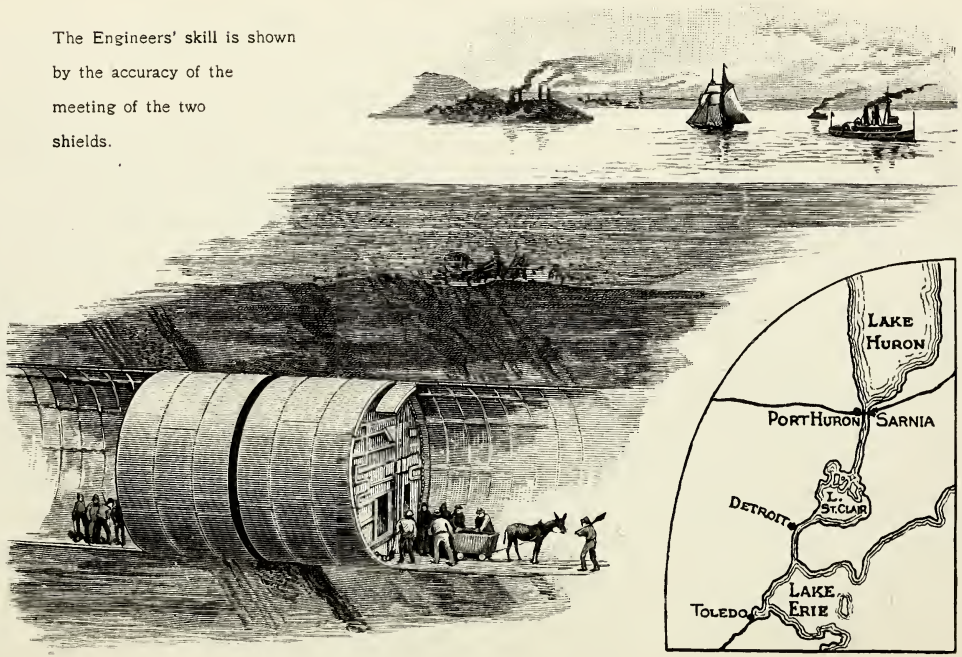
The tunnel was driven through blue clay. Above flows a swift river, forty feet deep. Between the tunnel and the water are from fifteen to twenty feet of clay, sand and gravel.

The novelty and magnitude of this work, the difficulties met, and the boldness and speed with which it was done, have made it a matter of great interest to engineers all over the world.

The Grand Trunk Railway crosses the St. Clair River from Sarnia, Ontario, to Port Huron, Michigan. On the St. Clair River there is a shipping commerce five times as great as that which passes through the Suez Canal.

The river is from half to three-quarters of a mile wide, and the current flows at from six to eight miles an hour.

The Engineers' skill is shown by the accuracy of the meeting of the two shields.



The Hydraulic Shield.

For many years trains were taken across on great ferry-boats. This was comfortable enough for passengers, but it wasted precious time; the boats were expensive to keep up and to operate, and in winter, when the river is full of floating ice, the delays and cost were serious.

To carry the tunnel through clay, with occasional pockets of gravel and quicksand and with a great river flowing only fifteen feet overhead, and to protect the workmen from accidents, was a difficult problem.

It was decided to do the work inside of steel tubes, called shields, which should be pushed ahead as the work advanced, and to line the tunnel with rings of cast iron close behind the shields when they were driven forward. In this way the danger of collapse of the tunnel would be avoided, and it would be practically finished as fast as it was dug.

One shield was started in from the Michigan side and one from the Canadian side. Each of them was a tube twenty-one feet and six inches in diameter, and fifteen feet three inches long. It was made of steel plates one inch thick. The plates at the forward end of the tube were sharpened to a cutting edge all around the circumference.

This tube was stiffened by steel plates put in up and down and crosswise, dividing the inside into square cells. Five feet from the back end of the tube was a partition, also of steel plates, in which were two square doors near the bottom. The men worked in the front part of the tube, cutting down the clay and throwing it back through the doors. Then it was loaded into small cars and hauled away to the rear on a narrow railroad track, by mules or horses. There was a second track to bring in the empty cars.

As fast as the shield went forward the tunnel was lined with rings of cast iron. Each of these rings was twenty-one feet in diameter and eighteen inches long, measured in the direction of the length of the tunnel. The ring, being of less diameter than the shield, could enter the rear of it; and so there was always a complete tube of steel and iron from the face of

the clay where the men were digging to the entrance of the tunnel.

Each iron ring is made of thirteen pieces of cast iron, each piece weighing about half a ton. The pieces are bolted together, and each completed ring is bolted to the one behind it so that the tunnel is lined with a continuous tube of iron two inches thick and water-tight. The cast-iron lining weighs about twenty-seven thousand tons. The shields were pushed forward by hydraulic jacks. The hydraulic jack is a cylinder into which water is forced; and the water, entering, pushes a piston just as the steam in a locomotive cylinder pushes the piston to one end or the other of that cylinder.

The hydraulic jack can be made to give power. Each shield had twenty-four of these jacks in the rear end, placed in a circle close to the shell, or outside plates of the tube, and also so placed that when their pistons were thrust out they would push against the cast-iron ring forming the lining of the tunnel.

They could push with a force of three thousand tons — a power sufficient to lift up bodily a large ocean steamship. This tremendous power was found to be twice as much as was needed to force the shield forward into the clay.

At each step the shield was pushed along eighteen or twenty inches. Then a new ring was added to the tunnel lining; the clay was cut down as far as it could be done safely, and carried away. Then the shield was pushed forward another step.

This was all very simple so long as the work was under the dry land; but when it reached out under the river it was necessary to find some way to keep the water out. Otherwise, when seams of loose material were struck, water would have poured in and flooded the tunnel, and stopped the work entirely. To prevent this, compressed air was used.

Every one knows that he can hold up a column of water with a column of air. Let him fill a U-shaped glass tube half full of water, hold it upright, with the open ends upward, and blow into one end of it.

The water will rise in the other leg of the tube, and the

harder he blows the higher the water will rise and the longer will be the part of the tube free from water.

Now, if one could put a fly in the dry leg of the tube and stop the end of it, the water would be held in the other leg, and the fly could move about at his pleasure, dry-shod.

This is the principle on which compressed air has long been used in deep foundations and other work under water. At the St. Clair Tunnel the dry leg of the tube was the tunnel; the wet leg was the river, and the workmen were the flies.

It must be remembered that in all of this description I speak of one-half of the tunnel. It was built from the United States side and from the Canadian side, simultaneously, and the work

Profile of the Tunnel.

at each end was entirely independent of that at the other, until the headings met under the middle of the river.

A brick partition, eight feet thick, was built in the tunnel just where it passed below the edge of the river. This was to hold the air in the tunnel. The air was pumped in through tubes built in the brick partition, and the pressure was always kept up to the point where it balanced the weight of the water overhead.

It will be understood that the deeper one goes, and the higher the column of water, the greater the air pressure that must be carried.

The men, mules and clay cars went in and out of that part of the tunnel which was filled with compressed air by means of an air-lock in the brick partition. This was a big tube extending through the partition with a door at each end, both doors opening against the air pressure — that is, toward the working end of the tunnel.

To get into the tunnel from without, the air in the lock was

allowed to escape until the outer door could be opened. Then one entered the air-lock, shut the door and opened a valve by which compressed air from the tunnel ahead was let into the lock. When the pressure there was equal to that in the tunnel ahead, the inner door could be opened and one could pass into the tunnel. To get out the process was reversed.

The painful part of the journey is in the air-lock, at the time when the pressure is changing. There people often suffer severe pain in the ears from unequal pressure on the two sides of the ear-drum, and sometimes the suffering is so great that they cannot go on.

After one has been a little while in the compressed air the pain ceases; but there is a trouble which is peculiar to working in compressed air, and which disables a good many men. The men call it the bends. It is a paralysis, more or less complete, of the muscles, and especially of the muscles of the legs.

Sometimes it is not painful, but often it is very painful indeed. At the St. Clair Tunnel horses could not work in the compressed air, but mules stood it well, though occasionally one of them was visited with the bends.

The pressure of air carried was ten pounds per square inch at first, and twenty-three pounds when the middle of the river was reached. At times it was run up to forty pounds. Of course these pressures are in addition to the normal atmospheric pressure of fourteen pounds per square inch, which is always present on every body and every surface in the open air.

The air pressure was kept up by pumps, and to guard against accident there were two sets of air-compressors at each end of the tunnel. If the supply of air had failed for a moment the water would have rushed in and drowned the men.

Besides the air-compressing plant, machinery had to be provided for pumping out any water that drained into the tunnel during the work, and other machinery for lighting it by electricity. There were hoisting engines and derricks with which to lift to the surface the dump cars as they came out loaded with clay.

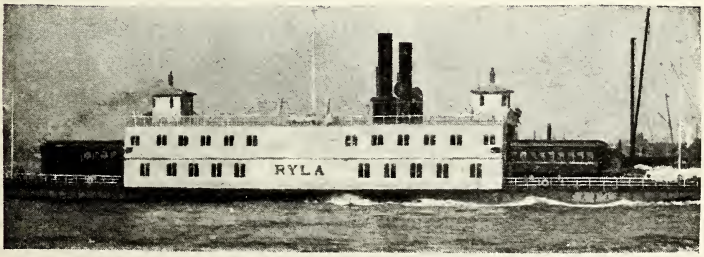
It happened repeatedly that the shields, as they were forced forward, entered pockets of gravel or quicksand going deep down into the blue clay. Then the air would escape through the loose material, and the water would begin to flow in.

Generally this could be stopped soon by increasing the quantity of air pumped in, but not always. Sometimes the air blew out through the bottom of the river so fast that the air-pumps could not keep up pressure enough to stop the flow of water.

More than once it seemed as if the tunnel would be flooded in spite of all that could be done, but luckily the engineers were always able, by plastering over the face of the gravel with clay, and by working the air-compressors up to a pressure of as much as forty pounds to the square inch, to hold back the water long enough to get the shield through the loose gravel into the clay beyond.

On the thirtieth day of August, 1890, the shield from the United States shore met that from Canada, under the middle of the river. This was just one year after they started on their strange journeys ; and I do not believe that any one was happier or more thankful than was the chief engineer of the St. Clair Tunnel on that August day.

H. G. Prout.



Winter-Fishing on Saginaw Bay.

Most boys and a few girls know something about fishing for trout, pickerel or bass in the brooks, ponds and rivers, and many, no doubt, have fished in the sea for cod and mackerel.

Fishing, in fact, is a popular recreation in nearly all countries. For this reason it may be interesting to many readers to hear something of a method of fishing, less well known than the tactics of the hook and line, such as is practised through the ice of the Great Lakes of our country in winter.

But first let me ask our younger readers to fetch the atlas, or geography, and turn to the map of the State of Michigan, and find Saginaw Bay, an indentation in the northeastern shore of lower Michigan, about seventy miles in depth and sixty miles in width at its junction with Lake Huron.

The shores of this great Bay curve gradually toward each other, until they reach the famous Saginaw River, from which the Bay derives its name.

About forty miles down the Bay the Charity Islands stretch across its centre, and, to some extent, protect it against the wild northeast storms of that region.

In mild winters there is always open water above the Charity Islands, and the ice, from five to ten inches thick, is often more or less broken up, and dangerous for fishermen; but in cold winters the Bay will be solidly frozen out to the islands, and sometimes far beyond them. I have been on it, ice-boating, when there was no obstacle in the way of a sixty-mile run, with much of the ice-field as smooth as glass, over which our boat would fairly fly in a wild race with the wind.

On this huge winter park there have been known to be, at one time, as many as two thousand five hundred people engaged in fishing. It might be deemed a risky place on which to live, and yet, with the ice thirty-six inches thick, without a bubble, there is not the slightest danger until the warm days of spring.

The fisherman's house is unlike anything else ever made for people to live in, and you would say, if you were a stranger in an ice village, that the huts must have been built for dogs, for they are just about like dog-kennels, only they are not nearly so well made as most such kennels.

The shanty, for that is the name by which the winter house is known, is from five to six feet long, by about two and a half to three feet wide, three and a half feet high at the eaves, with a sharp pitch roof; so that directly under the ridge a man of ordinary height can stand with head and shoulders a little bent.

Fishing Shanties.

This pigmy structure is made of rough boards, and covered all over with tarred paper. The floor is of loose boards, laid on the ice. The furniture consists of a narrow wooden bench, extending along one side, which serves as a seat by day and a couch by night.

Wedged in at the rear end is a little sheet-iron stove, scarcely larger than a big frying-pan, on which stands a small spider and a coffee-pot. At the front end is a door, so small that the fisherman has to bend on entering the house.

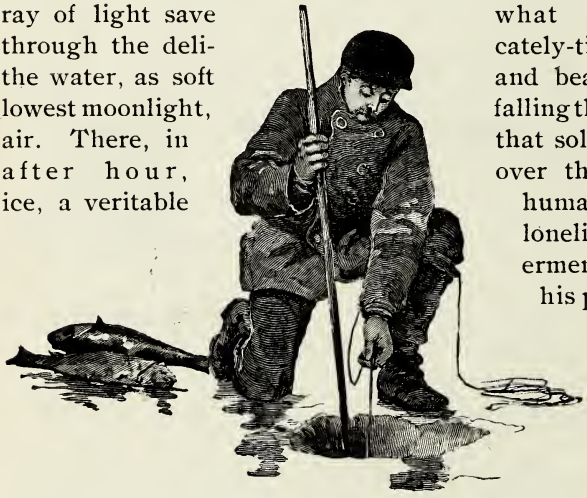
Just inside the door is the fishing-hole, about eighteen inches square, in which the water rises almost to the surface, and from which every speck of ice has been carefully removed.

Above this hole in the ice is a small hole in the roof, through which the spear-handle is passed when removing it from the water, but which is kept tightly closed when the fisherman is at work. The spear-head has six barbed prongs of fine steel. The

handle is about seven feet long, and is secured by a strong cord to the roof. On one side of the handle a screw, about three feet from the spear-head, serves as a rest, and holds the spear perpendicularly in the hole.

The spear is thus supported by the screw, which is caught on the edge of a floor board. In that position it is at the right hand of the fisherman, ready for instant use.

Having seen the shanty, let us now follow the fisherman into it and observe him at his vocation. Getting inside, he closes the door carefully, thus shutting out every ray of light save what is sifted up through the delicately-tinted green of the water, as soft and beautiful as mellowest moonlight, falling through summer air. There, in that solitary cell, hour after hour, over that hole in the ice, a veritable human cat, sits the loneliest of lone fishermen, waiting for his prey. In his left hand he holds a slender cord, to the lower end of which is attached a decoy. The decoy is a herring, when it can be obtained. When the fisherman cannot get a herring, he uses an imitation one, made of wood ballasted with lead and trimmed with tin fins and tail and glass eyes; and this herring-decoy is a beautiful imitation, as seen twenty feet below in the water, with every scale shining as white as a new silver coin.



Fishing through the Ice.

The fishing is done in water the depth of which varies with the run of the fish, which is at times well inshore and again off, in thirty, fifty and seventy feet of water. The decoy-line is

knotted at a point that will bring the pursuing fish up to within eighteen inches of the spear; so that when that knot reaches the fisherman's hand he knows just about the distance he has to drive his spear.

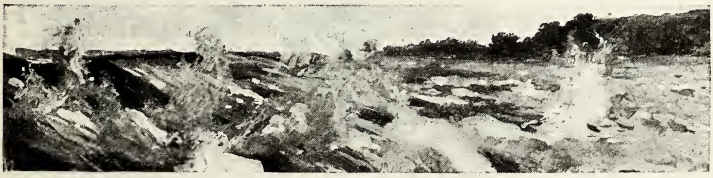
When the fisherman goes to work he drops his decoy well toward the bottom, or as far as he can see it, which is a long distance in the clear, still water. As soon as a fish appears, the decoy is moved carefully upward, the darkness of the closed shanty preventing the fish from seeing the movements above him, while he can be seen as distinctly as if he were on the surface.

When the fish hesitates, the decoy stops; if the fish starts forward, the decoy is drawn farther up. If he retreats, it is lowered toward him. Thus the trick is played until the fish becomes excited and rushes in upon the coveted prey. The line is then rapidly hauled in until the knot reaches the fisherman's hand, when he grasps his spear and drives it into the back of his game.

The fish thus speared are now chiefly pike, although along the Straits of Mackinac many lake trout are still speared in winter, and in some places whitefish are caught in this way, but only rarely, as they are not a game fish and are protected by law.

But when white men first came to Saginaw Bay to fish they caught large quantities of splendid trout, the largest ones weighing from fifty to seventy pounds.

CHARLES ELLIS.



Dog-Sledges in Michigan.

Although dog-teams are no longer used in the lower peninsula of Michigan, they have not ceased to be employed near the Straits of Mackinac and in the upper peninsula. Until fifteen years ago, when the railroads were pushed through the forests as far north as Marquette, dog-trains were necessary for carrying the United States mails. They are still an important motive power in many remote places where canoes in summer and dog-sledges in winter are the only methods of travel.

In my early life in Saginaw, the coming of the dog-train from Marquette was one of the sensational events of a winter in the pine woods. These trips were made at intervals of two weeks from the closing of navigation in November until its opening in April or May.

Saginaw was at one end of the route, and I have often seen the weary dogs climb the river-bank at the close of their tedious journey of ten days. For safety they had to travel near the shore, and often upon the ice, so that the length of their route was estimated at six hundred miles, though the distance between Saginaw and Marquette by rail is only about three hundred and seventy-five miles.

The sledges in use at that time were shaped like toboggans, and were each ten feet long and about fourteen inches wide, with the front curved. These sledges were the property of the United States government, and their chief mission was to carry the mail, which was packed in close parcels, covered with waterproof canvas, and tightly strapped to the sledge, the whole being lashed with buckskin thongs to a leather band fastened to the edge of the board.

The sledges always went in pairs, each having four dogs and two couriers. These men were half-breeds and wore a costume peculiarly their own. Over heavy woollen underclothing they

wore a coat made from a Mackinac blanket, usually gray with black stripes; a hood of the same material was attached to the back of the coat's neck, and this hood was drawn over the fur cap at night or in very cold weather. A bright red scarf girded the waist. The breeches were of tanned buckskin; the feet were well protected by deerskin moccasins and several pairs of heavy stockings, the outer pair of a bright red.

Dog-Sledges on the Journey.

Snow-shoes were always included in the outfit, being necessary where snow was deep.

The dogs travelled tandem, with harness of collar, back bands and traces. Sleigh-bells were attached to the collars, which were frequently ornamented with bead work and gay worsted tassels. The best dog was called the leader; the rear dog was called the steerer, as he often had to display ingenuity in keeping the sled upright in difficult places.

The regular sledge dogs are a peculiar breed, known as huskies, supposed to be a corruption of the word Eskimo, and

are derived from dogs of Eskimo stock. They have small heads, long noses, short but pointed ears and bushy tails. Their cry is a yelp rather than a bark, and is thought to resemble the noise made by a wolf.

While faithful to their task, they are quarrelsome, and are not generally treated in a manner to develop the better side of their nature. They are not guided by reins, but entirely by the voice and whip; hence they are shouted at and shrieked at in French, Indian and English.

One courier runs before the team, the other follows the sledge, often aiding its progress by means of a long stick which extends from the rear at an angle of forty-five degrees.

When semi-monthly trips by dog-team supplied, for six months each year, the only means of communication between the world and the people in our northern wilds, the returning sledges were usually loaded with accumulated papers and magazines. Other parcels were often carried as freight for a stiff price. Occasionally there would be a passenger, if that word can be applied to a man who paid from five dollars to fifteen dollars for the privilege of accompanying the sledges.

The route was through a trackless forest or over great fields of ice, with at least half of the nights to be passed under no shelter but the pine-trees and with a snow-bank for a bed. Provisions for both men and dogs were always carried; the food for the dogs consisted of Indian meal and tallow.

Men and dogs showed great powers of endurance, making forty, fifty or sixty miles a day, according to the condition of the snow and ice, and doing the whole journey with much regularity. Nothing short of a most extraordinary storm retarded the arrival and departure of the mail-trains. In a storm, or if bewildered in regard to location, the couriers trusted entirely to the dogs, who never failed to keep the right course.

Nowadays, for short journeys sleds mounted on runners are used, but they would not be serviceable in very deep or soft snow. While dogs are not so necessary to the settlers as twenty years ago, they are still employed in the northern part of the

State. The fishermen all along shore keep dogs to carry their catch to market, and to bring wood and other supplies to their isolated huts.

There are many fine teams kept for the pleasure of their owners, who consider them more desirable than horses in that cold region, as they can lightly pass over great drifts of snow and brave the wildest storms. Missionaries frequently employ dog-teams. In 1896 one of them travelled nearly four hundred miles with his dog-sleigh through the wilds of northern Michigan.

Turk and Punch were with difficulty broken to the work required of them. In telling me of his experiences in travelling, the missionary said:

"While at work the dogs are fed but once a day, and that at night when their work is done. This does not in any way betoken cruelty to the dogs, for they do better work, with less fatigue, than if they were fed three times a day. My dogs weigh over one hundred pounds each, and were in a much better condition at the end of the season than when they started out.

"Turk took kindly to his duty from the first, springing to his proper place the moment the sleigh-bells were heard; but Punch would growl and snarl, and had to be forced each time to his position by the side of his amiable mate, who patiently awaited the word, 'Go!'

"Then, with little impatient yelps and sleigh-bells jingling, they bounded over the huge drifts of snow, through the pathless woods, often making eight miles an hour."

MERCIA ABBOTT KEITH.

The Ishpeming Dog-Race.

The upper peninsula of Michigan, that great stretch of big pines, barren plains and rugged hills seamed with mineral riches, has one custom which is probably unique. It is the annual dog-race, which is regularly held at the beginning of the year in several of the larger mining towns.

Its origin dates back to the times, not more than a half-century ago, when the Canadian French and the Chippewas were almost the sole residents. The Indians lived as they did in the days of Hiawatha, except where the patient missionaries had founded little churches, around which clearings had been made, and half-civilized and half-Christianized Indians were gaining a living, partly by the chase and the trap, and partly from the products of their little farms.

The French settlers were trappers and farmers, and their means of gaining a livelihood and their manner of living differed little from that of their dusky brethren.

In those days the sailboat and rowboat in summer, and the dog-train in winter, were the sole means of transportation. The government mails were carried at stated intervals by hardy half-breeds or equally hardy Canadians in their boats or upon their backs in summer, while during the long winters, beginning in November and rarely ending before May, the dogs were compelled to take the burden. Sometimes strongly-built sledges of home manufacture were used, and as frequently the Indian toboggan was pressed into service.

In the larger mining towns, such as Ishpeming and Calumet, the annual dog-race is looked forward to in winter with almost as much pleasure by Young America as is the Fourth of July in the summer-time.

In Ishpeming at one New Year's festival, although the day was bitterly cold, with a furious wind seeking the ears and noses of the people on the streets, five thousand persons

assembled along the race-course, which was on Bank Street. The windows of the buildings facing on the street were crowded with ladies and children, while even the statue of the Chippewa chief on the square upheld several enterprising youngsters, who there obtained a good view of the start.

With great difficulty the line was formed. The entries in the first class were thirty-two in number; and the line of dogs, sleds and boys stretched across the street. The judges and starters

The Big Newfoundland Leads.

were assisted by the marshal, in his fur overcoat and fur cap, while policemen stood conveniently along the course to keep back the overeager spectators.

The sight was a strange one. Boys of all ages from eight to sixteen were seated upon sleds of all styles, including several of home manufacture. Attached to these sleds by harness and tackle of every variety, from the made-to-order leather harness

to the hastily-constructed gear of rope and twine, were dogs of all sorts and conditions. There were sorry curs of low degree, and shaggy Newfoundlands; there were huge mastiffs and slender greyhounds; and every dog and every driver were bursting with anxiety for the word to start.

The starter said "Go!" and the dogs went. Four or five of the number shot swiftly forward, others travelled more slowly. One huge St. Bernard made a desperate leap which was too much for the worn harness, and his young driver was left behind. Another boy was caught off guard, and left rolling in the snow while his steed was dragging an empty sled toward the turning-point. Two other dogs started at cross-purposes, and dogs, boys and sleds were tangled in a snarl which lasted till the fleeter racers had reached the turning-point, three blocks distant.

Of the number entered, but five or six displayed genuine racing qualities. One poor youngster, whose dog was well to the front, was sorely disappointed when his Towser, despite urgent entreaties and the liberal application of a whip, turned at the last corner before the goal and ran home at the top of his speed. That dog went supperless to bed that night. His youthful master faced the gibes of an unfeeling public, composed of his young neighbors at school, the next morning.

The second heat was almost a repetition of the first, though the starters were ten less in number. A big Newfoundland came in ahead both times. His driver had no whip, and needed none. Even boys who drive dogs sometimes learn that neither boy nor dog can have his best endeavors brought out by the use of a lash. The boy who learned this lesson was richer, a half-hour later, in the possession of the best suit of clothes that could be found in the city, for that was the first prize.

The races continued for nearly two hours, the entries growing fewer in number toward the last, while the racing was better. The boys owning refractory dogs, or dogs unnerved by the presence of five thousand spectators, were compelled, reluctantly, to withdraw from a hopeless contest. From the side streets

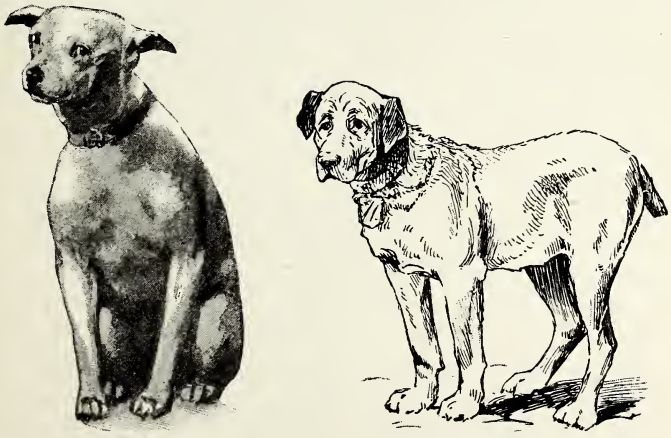
there frequently arose howls from luckless dogs, suffering chastisement at the hands of their aggrieved drivers.

At last the races were over. Skates, sleds and dog harnesses were the prizes. The last prize was a mammoth soup-bone, and it was expressly stipulated by the management that this should be for the exclusive use and enjoyment of the winning dog, and not the boy.

The competition for this prize was not so brisk as when sleds and skates were at stake; but there were four entries, and a mangy yellow cur that had never been in sight of the quarter-pole before that day trotted off with the soup-bone.

His ten-year-old owner and driver — for this was a gentleman driver's race, only owners being allowed to act as jockeys — went home with tears in his eyes and the firm conviction that his beast could have easily won for him that suit of clothes, but preferred, out of the meanness of his canine nature, to win the soup-bone for his own carnal enjoyment.

HORACE J. STEVENS.



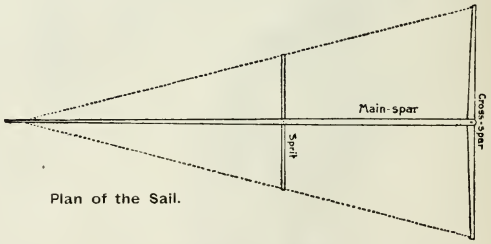
Neither Won.

A Wisconsin Skate-Sail.

Of skate-sailing in general less needs to be said now than a dozen years ago. It is a wonderfully fine and fascinating sport, based on the longing for wings. Who can stand skate-shod on the ice with a fresh breeze blowing, and not feel that longing? But although many of us boys had long felt that desire, it was only with the introduction of the form of sail of which I write, and which is used by the boys in Wisconsin, that skate-sailing came into great popularity among us.

Our sail is, to describe it in the simplest terms, simply a triangular piece of cloth, stretched on a T-shaped frame, carried to windward but unattached to the body. One of its chief merits is its simplicity. Yet it has other excellent qualities; I know of no other form of sail with which so large a wind-surface can be carried with such complete safety.

It is a safe sail because it is unattached to the body; with a little experience one can even drop it upon the ice if it becomes necessary. In using a sail which is fastened to the body there is always the danger, especially in a gusty wind when skate-sailing is at its best, of one's sail becoming unmanageable.



Plan of the Sail.

The frame consists of two pieces. The length of the cross-spar should be about twice the distance from the ground to the armpit of the boy as he stands upon skates. Thus, for a boy of sixteen the cross-spar should be perhaps eight feet long, and the main-spar should be twice the length of the cross-spar. The sail should be made of heavy unbleached muslin or sheeting, cut of such a size that, after hems have been made all around, the

sail shall be a trifle narrower at the wide end than the length of the cross-spar, and about a foot shorter when stretched than the main-spar.

The sail is carried on the windward side of the body, the main-spar being held under the arm about three or four feet from the forward end. The lower end of the cross-spar comes a few inches above the ice; the rear end of the main-spar drags.

Sailing Before the Wind.

The centre of resistance is about one-third of the distance from the forward end. The whole problem of steering is involved with one's relation to this point.

If you are going directly before the wind, you should be just at this point. If you are tacking, you should come a little forward. If you would come into the wind, steer closer with your skates and come to the front of the sail, when, of course, all the wind is spilled behind. To come about, the sail is shifted to the other arm by being passed over the head and turned upside down. There is always perfect safety so long as you are able to come forward of the centre of resistance.

Now, if you are ready let us take a long flight up the river.

There is a strong and gusty gale, the kind of wind that makes you love the sport. The hard surface of the ice stretches out before us far and wide, polished and smooth, and ringing, when struck, like a plate of finely tempered steel. We are off!

How the wind rushes! But we know you of old, Boreas! Many a time have we wrestled with you upon this glassy arena! We speed away with a swoop, the sharp steel hissing, the wind stinging our faces, the spray from our skates whirling over the surface. Braced with all our strength we lean far over upon the wind. Yet a stronger gust has seized us, and we are whirled away like leaves across the ice.

But here we are at the end of our course, and we rush up into the wind; it howls and roars about us, and the sail shakes and quivers. Again we are off on our wild flight back.

There is joy in an ocean-swim, through the surf and out upon the great waves. There is joy in swimming in the brown water of some Northern river among great, fragrant logs. I remember moments when tearing over the ice on skates after a shinny-block seemed the most glorious thing in life.

Again, there are the memories of long skatings off into the sunset, with fine feelings of freedom and power. Or our skates have led us on into quiet bayous, which stretch back into the depths of the solemn forest. We linger to watch the colors in the west through the branches and among the great trunks of the elms. Then, as we turn homeward in the phantom light of the moon, we hear the reverberating cry of the great owls, and the river begins solemnly to boom with the settling down of night.

Among a host of such happy memories I count many a glorious sail on skates.

A. W. WHITNEY.

A Trip to Lake Superior.

The first of July found me sitting on the forward deck of a fine, stanch steamer lying at her dock in Detroit. I was surrounded by fishing-rods, reels, rubber boots and the usual equipments of fishermen. With me was a young companion, Arthur Denison: we were bound for a trip to the Lake Superior country.

Passing through the turbid waters of Lake St. Clair, by Port Huron and Sarnia, we soon found ourselves tossing upon the angry waters of Lake Huron.

The next morning early we were at a small island noted for producing more raspberry jam than any other manufactory in the United States. The berries were picked by the Indians and manufactured into jam by the thousands of gallons annually.

Once more under way, and we soon entered the St. Mary's River, and in a few hours were at the rapids, waiting at the mouth of the canal for our turn to pass through.

As we were obliged to wait an hour or two at this point, we took a stroll, and soon discovered several Chippewa lodges, in one of which lived an old squaw, said to be one hundred and seventeen years old.

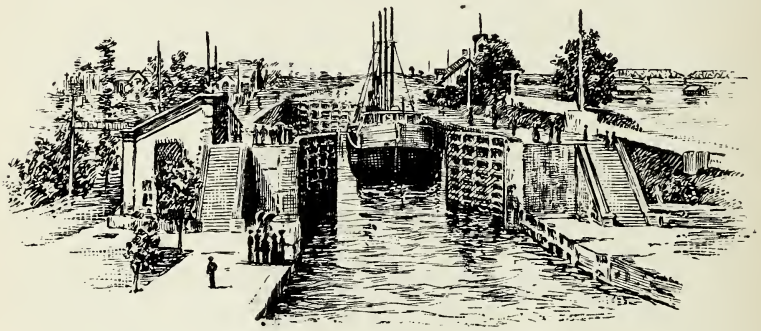
These Indians earned a precarious living by catching whitefish in the rapids, and making boxes and baskets of birch-bark and a fragrant grass that grows in the vicinity, which they sold to visitors.

We stood on the shore for a while, and watched the Indians catch the fish. Two of them entered a birch-bark canoe, so light and frail that it seemed almost as fragile as an egg-shell. They paddled up until they reached the first fall in the rapids, then one of them took his place in the prow with a scoop-net, and the other steadied the canoe with his paddle.

The Indian in the prow stood so motionless that Arthur

thought he must be asleep; but suddenly we saw the net descend, and in a moment it rose all dripping with water, and a fine large whitefish was deposited, gasping, in the bottom of the canoe.

Again on board the boat, we slowly steamed in between two high walls of stone, a pair of immense gates were closed behind us, and then the great boat began to rise slowly, and in a few minutes we were in another lock; the great gates again



Steamer in the Lock.

closed behind us, and then we rose to a level with the lake before us. We thus passed around the rapids in the great St. Mary's Falls Ship Canal, and were fairly launched on the bosom of the great lake, whose green waters extended for nearly five hundred miles before us.

Just as the sun rose the following morning, the captain called us to come on deck, and a remarkable sight greeted our eyes. Every one asked, "Why, where are we?" and the captain finally told us, "In Le Portail." The great steamer, with its tall masts and smoke-stacks, was in an immense cavern, more than a hundred feet high.

"Look," cried Arthur, "how can the boat stay here? The water isn't more than two feet deep."

But the captain told us that it was more than twenty-five

feet deep. Yet so clear and transparent was it that we could see the delicate tints and colors of every pebble on the bottom as plainly as though they lay in our hand.

In a short time the great steamer backed out of the cave, and in a few hours more we found ourselves along the busy docks at Marquette, over which millions of tons of iron ore are annually shipped to the great manufacturing centres of the world.

The captain sent for Steve, a well-known half-breed, who was soon along side the dock with his neat and clean "Lady of the Lake." Our rods, trolling-lines and our luncheons, were soon in the boat. Steve took the oars, and away we leaped over the emerald-green waters.

Before we had been out five minutes, Arthur asked:

"When shall we begin to fish?"

"Good time now," replied Steve, who gave a nod of approval of our "spoons," and overboard they went.

We watched the bright-silvered, gaily painted trolls, as they glistened far behind us in the clear water, and pretty soon Steve said, "That's enough," and we stopped paying out our lines, and anxiously waited for a bite.

Arthur soon exclaimed, "I've got a fish! I've got one! Let me pull him in! Don't touch the line!"

"Steady! Pull steady!" said Steve; and in a few minutes a six-pound Mackinac trout lay flapping in the bottom of the boat.

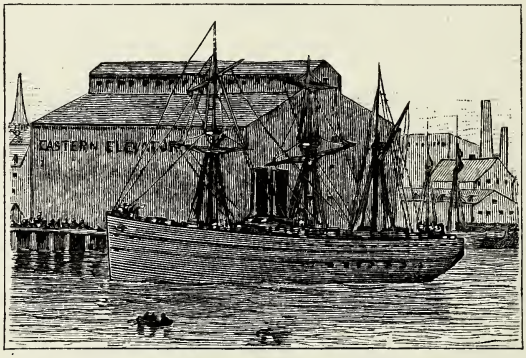
The fish came so fast that our hands grew both tired and sore, and we were glad to hear the guide suggest pulling inshore towards a small rocky island near the mouth of Cart River, that we might try our luck at speckled trout.

Our rods were soon jointed, our reels attached, lines fastened, and in a very few minutes after our keel struck the pebbly beach we were on the rocks. I threw a small black fly with gaudy wings, and it had scarcely struck the water before a noble fellow seized it.

The sport went on, until we heard the hoarse whistle of the

"Ironsides"; and though Arthur declared, "It's too bad!" we took the boat, and Steve soon landed us and our precious cargo at the dock.

Morning found us in Portage Lake, and we visited two of the largest towns in the Lake Superior country, near the richest copper-mines in the world. There all is life and



Steamer at Detroit.

activity, and we saw the locomotive come puffing out of the bowels of the earth with its car-loads of ore.

On our way back we visited the Minnesota and National mines, where we descended the shafts to immense depths, and saw the grimy miners, with their little safety-lamps fastened in their hats, as they delved and toiled for the precious ore, some of which contains large quantities of virgin silver.

At Ontonagon we met the man who carried the mail during the winter season, and furnished the only means of communication that this thriving settlement had with the outside world during the long, cold winter. He was a half-breed, and with his train of noble dogs and sledge, made an easy sixty miles per day over the frozen crust with his mail-bags.

SAMUEL W. COZZENS.

Hop-Picking in Central New York.

In many a quaint old farmhouse, from the middle of August until the first of September, numerous preparations are made for the gathering of the hop crop. To the hop-grower it means a season of anxiety and hard work; to the pickers a sort of holiday, combined with the satisfactory prospect of making a little money.

The good wife certainly has her hands full at this time. Every available space is utilized for sleeping accomodations; beds are spread in the parlor, hall and attic, and the male portion of the help often sleep in the hop-house.

The fattest lambs, the choicest chickens, are all sacrificed to appease the hungry pickers. There seems to be a rivalry among the farmers as to who will set the best table. Perhaps it is for their interest to do this, as oftentimes there is a scarcity of pickers, and the farmer who has the reputation for good living seldom has trouble in securing help.

When they are in the condition for picking, the hops must be gathered at once, as a delay of a few days would result in a serious loss to the farmer.

In certain localities near villages the pickers often board themselves, bringing their dinners, and returning to their homes at night; but the majority of the growers board their hands. Almost every one in this section goes hop-picking, the rich and poor, the young and old, oftentimes whole families, in which latter case the earnings are considerable.

It is a pleasant sight to watch the pickers going to their daily task. There are many well-dressed people, matrons, pretty girls and young children, all looking fresh and cheerful, with their lunch-baskets on their arms, all chatting and laughing, and appearing totally unconcerned as to the task before them.

Yonder comes a lumber wagon loaded with a farmer's whole

family. Among them is one woman, perhaps seventy years old, bringing her easy chair to sit in while picking. The mother has the baby on her arms, who will soon be sleeping sweetly beneath the graceful clusters of hops.

The hops as they are picked are put into boxes. The main box is divided into four separate compartments or boxes,

In the Hop-Field.

each holding eight bushels. There are four pickers to a main box, each picker having his own box holding eight bushels. The number of boxes picked by a person in a day depends upon the abundance of the hops, their size, and the ability of the picker. The general average is, perhaps, from two to four boxes per day.

The wages paid range from thirty-five cents to fifty cents

per day when the picker is boarded, or from fifty cents to seventy-five cents when he boards himself.

Every main box has a box-tender whose business it is to pull the poles, strip the vines from them, and keep the pickers supplied with hops. It is quite a responsible position, as it is also his duty to see that the poles are picked clean, the hops in the boxes kept free from leaves and stems, and no hops wasted on the ground.

As soon as a box is filled, it is sacked by the box-tender, the picker holding the sack while the box-tender puts in the hops, carefully picking out every large leaf and stem, and frequently admonishing the pickers to pick their hops a little cleaner. A setting comprises six rows of poles from each end of the box, and three from each side. When these are all picked, the box is moved forward to another setting.

A busy, merry throng they are, with their nimble fingers working swiftly over the vines.

Noon soon comes, the gala event of the day, but none too soon, for the bracing air, the pleasant exercise and the good spirits of the company are all conducive to an appetite that is a stranger to those working in stores and factories in large towns and cities. A shady spot is selected beneath some grand old tree, or in some grove beside a spring of sparkling water, and here a table is spread on the green grass.

Such a variety of good things! Cold turkey, chicken, geese, meats of all kinds, sandwiches, and innumerable pies, cakes and puddings; jugs of cold coffee, tea, milk and lemonade, but never any malt or spirituous liquors. In an experience of twenty-five years, I never saw a drunken person in a hop-field.

The women gossip as they eat, and in the pure air, with the cool breezes from the hills fanning their sunburnt faces, their loquacity seems to be so increased that it would leave any traditional tea-party far behind in the race of tongues.

John H. Adams.

Charcoal-Burners.

Charcoal, as made in the forests of the United States, is used principally for fuel in iron-smelting furnaces. In Pennsylvania, for instance, many of the smelting companies own timbered land and employ charcoal-burners, or coalers, as they call themselves, to convert the wood into charcoal.

The men who call themselves coalers are not all directly employed in charring the wood; indeed, the majority of them are simply choppers, who fell the trees and cut them into cord-wood lengths. Thirty men are required through the winter to cut the wood that ten of the gang can afterward char, and these ten are truly coalers. They are generally sons of charcoal-burners, while the choppers are commonly farmers' sons from the neighboring region.

When the superintendent of a furnace has decided how many cords of wood shall be cut from a certain tract, the location of a camp is settled and choppers and coalers gather there. Their first work is building cabins for the winter, as chopping is usually done between November and April. In the spring the coalers are left to deal with the wood, which has been piled in ranks near where it is to be charred.

The cabins are built of logs with mud daubed into the chinks. Smaller logs form the roofs, which are usually shingled with several layers of bark, though I have seen sods used instead. Against the cabin a chimney is built of stones and mud, with a fireplace opening into the one room of the dwelling, which is seldom larger than twelve feet by fourteen. Two experienced men can build such a house in three days.

The chimney is the coaler's kitchen; the bunk at the opposite end of the cabin is his bedroom, and his sitting-room is the space between.

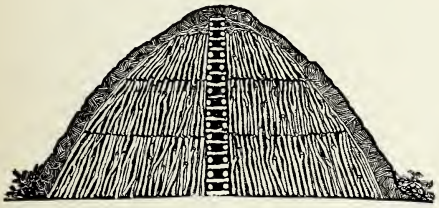
Having housed themselves, all hands begin to fell trees, chop them into lengths and pile these, each man keeping his wood in a separate rank or pile. About once a week the wood

boss visits the camp, measures the piles and credits each man with the amount he has made. A strong chopper can put up from three to four cords a day, and his wages vary in different years between thirty and forty cents a cord.

In Pennsylvania the choppers leave camp about the middle of April, when the coalers begin to build the pits, which are not holes in the earth, but simply large mounds that much resemble enormous ant-hills.

In constructing a pit the first thing is the building of the chimney. This is formed by laying sticks of wood in a square with the ends crossed, and so placing tier after tier till the chimney is about twelve feet high.

All around this chimney the wood is leaned slanting, as the coalers say, and placed in layer after layer till the whole is about twenty-five feet in diameter at the base. Usually about thirty cords of wood are placed in one pit. Then the wood is covered with a layer of dead leaves and afterward with earth, the purpose being to prevent air getting in or fire showing at any point except such as the coalers may choose. When covered with earth the pit is ready to be fired.



Plan of a Pit

This is done by dropping coals from the top of the chimney upon a little tinder laid at the bottom. As soon as the fire has taken hold the top of the chimney is covered with earth, and no draught of air allowed except such as flows slowly through the covering of leaves and earth.

The coaler must be ever watchful lest the wood, which he wishes to keep smoldering, should burn instead, and so yield not charcoal but ashes. If he sees too much smoke coming from any part of the pit he climbs up on a rude ladder and uses a kind of wooden hoe to increase the thickness and solidity of the earth-covering there. Sometimes a crater appears at some point

where the earth has fallen in or crumbled away, then the coaler must stop the hole with more earth. His business is simply to keep the slow fire well banked up.

If the weather be rainy he need not be so constantly on the alert as when it is dry; but if the wind be high he must be on guard day and night. A little neglect may let the banked fire gain such headway that it will largely consume the wood and destroy the prospect of a good yield of charcoal.

Thirteen days are commonly required to coal such a pit as I have described. But if the wood be light and the weather windy a pit may be opened at the end of eight days. If a man is industrious he may coal two such pits a month and earn from forty to fifty dollars, according to the quantity of charcoal, for which he is paid by the bushel.

Unfortunately the tick system prevails in Pennsylvania to some extent; hence the coaler is not always paid in money, but sometimes in tickets or checks for food or goods kept at the store of the furnace company. This pernicious system is disliked by the coalers, though they are usually contented men, who would not exchange their work for any other.

It is usually late in October when the wagons of the furnace company make their latest rounds of the camps and haul away any charcoal remaining at the pits. Then the coalers gather up their few utensils and move on five or six miles, to begin again the round of building, chopping and coaling.

How long charcoal will continue to be used for smelting purposes no one can foresee. But coke has taken its place in many quarters. Nevertheless many experts declare that no fuel is so good as charcoal for smelting pigs that are to yield such a high grade of malleable iron as is used for horseshoes, horseshoe nails and so on. But as steel is rapidly supplanting iron it is probable that the picturesque charcoal-burner will disappear from our forests within a few years.

E. B. Findlay.

Natural Gas.

The earliest Jesuit explorers of the Ohio Valley discovered and reported columns of fire issuing from the ground. In 1775 George Washington sought to have set apart and reserved to the public forever a square mile of land in the Kanawha Valley, in the centre of which was a burning gas spring that he regarded as one of the greatest of our national wonders.

The first use of natural gas for domestic purposes in this country was made in 1821 in the village of Fredonia, Chautauqua County, N. Y., where enough of it was collected and piped to supply thirty burners. The village inn was illuminated by this gas when Lafayette passed through Fredonia in 1824. At the same time a small lighthouse on Lake Erie warned vessels from the coast with a flame of the same product.

Natural gas is found in connection with petroleum and salt water deposits, and it was the gas that rushed from a salt-well, bored in Western Virginia in 1841, that was first used as fuel in a furnace. Here it supplied the heat necessary for boiling and evaporating the salt water, and enabled the owners of the well to make salt a little cheaper than other well-owners.

From the earliest development of the Pennsylvania oil-fields a portion of the gas that generally accompanies the flow of oil from a well has been used to heat the boilers of the pumping engines, and to warm and light the dwellings in their vicinity.

For many years, however, it was oil and not gas which the well-drillers were seeking, and they allowed millions of cubic feet of the gas to escape, or burn to waste daily, with little thought of its value. If it was lighted at the end of tall pipes for the illumination of village streets or dark forest roads, no one thought of turning it off at sunrise. By day as well as at night its lurid, torch-like flames burned on hilltops, in valley and forest throughout the oil regions.

In 1874 it was discovered that this fuel could be used more

effectively and cheaply than coal, in iron-works, glass-works and other manufacturing establishments. It was not until 1883, however, that the enormous volumes of gas supplied by the Murraysville field were directed through twenty miles of iron pipe to Pittsburg, and offered as fuel for the mills, factories, stores and dwellings of that city.

With its use for this purpose, the manufacturing business of that large city was revolutionized, its domestic comfort was greatly increased, and its whole aspect was changed. Not only does gas furnish a more regular and intense heat than coal, but furnishes it at a reduced cost, and does away with the labor of handling coal, building fires, keeping them supplied with fuel, and disposing of the accumulated ashes and cinders.

Gas Light.

It was not found necessary to make any material change in the construction of furnaces, open grates or stoves. Those built for coal are still used for gas. The only difference is that, instead of kindlings, coal, ashes, cinders, soot and smoke, there is a small pipe that issues from the floor and enters the grate. A stop-cock is turned, the gas is ignited, and any degree of heat required can be obtained at once and regulated at will. When no longer needed the flame is instantly extinguished, and all care of the fire is at an end. With a good draught there is perfect combustion and no odor.

Natural gas is found in both sandstone and limestone formations, at depths ranging from a few hundred to two

thousand feet, and is reached by wells bored in the same way as for oil. In fact, it often happens that a well sunk for oil yields gas instead. This was formerly regarded as a misfortune, but the gas has become as valuable as the oil, and drilling for gas is a well-established business.

Striking gas is a somewhat thrilling affair. As the ponderous drill crashes through the thin remaining crust of slate, and liberates the giant imprisoned for ages beneath, the column of gas leaps up the five-inch pipe with such force as violently to project the heavy boring tools, weighing a ton or more, through the derrick frame. The gas, with a screaming roar, springs a hundred feet into the air, a column of bluish vapor. Sometimes it tears the casing of cast-iron pipe from the well, and hurls after it volleys of earth and rock, mingled with jets of oil and salt water.

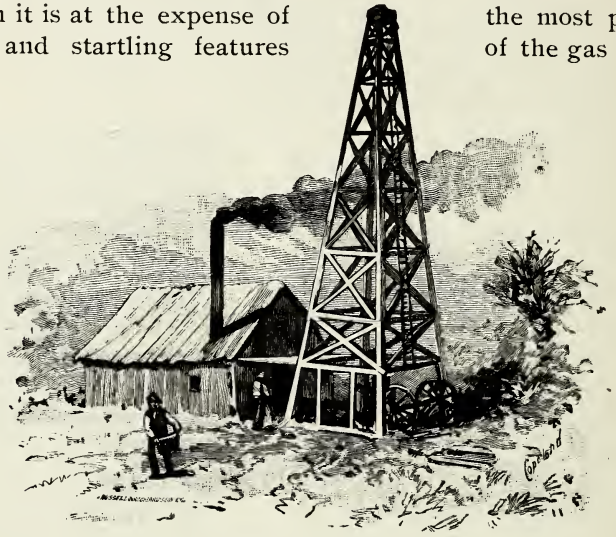
Of course not all gas-wells begin business in this boisterous manner. Most of them are of comparatively gentle flow and easy to manage, though such scenes as the one described are not uncommon in new fields.

The gas giant is fond of fire, and the moment he is loosed from his underground prison he begins eagerly to search for it. If it is found under the boiler of the pumping engine, in the bowl of a workman's pipe, or in sparks struck from flinty rocks, the pillar of vapor instantly becomes a column of flame, throwing out an intense heat, devouring and withering everything in its vicinity, and at night lighting miles of the surrounding country with its angry glow.

It may burn for weeks, months, or even for years, before its terrible strength is so exhausted that the torrent of flame can be extinguished and its energies subdued to the service of man.

During the past forty years the quantity of gas thus wasted has been enormous beyond belief, or power to compute. But this waste is now almost wholly checked. Devices have been perfected and adopted for seizing and controlling the vapor upon its first appearance in the well, and before it has drawn a single breath of air, without which its ignition is impossible.

Even the vast columns of flame that for so long baffled the efforts of the gas men can now be surely and safely extinguished, so that the gushers and roarers of new gas fields, with their pressure of four or five hundred pounds to the square inch, are conducted through a network of pipe lines to the scenes of their future usefulness without loss of time or money, though it is at the expense of the most picturesque and startling features of the gas fields.



Drilling a Gas-Well.

A singular spectacle was afforded by a well bored at Gambier, Ohio. The well, not having been tubed, repeatedly filled with water, which was ejected by the rush of gas at regular intervals of one minute. An intermittent fountain of mingled gas and water one hundred and twenty feet high was thus formed. In winter the derrick above the well became so completely incased in ice as to form a transparent chimney. By cutting a hole at the base of this ice chimney, and igniting the gas as it rushed upward, an effect was produced that at night was weird and beautiful beyond description.

Another fascinating picture is made by the miniature aurora

borealis that appears in the vicinity of blazing gas-wells on clear, cold winter nights, when the air is charged with minute ice crystals. The darkness glows and sparkles with broad bands, streamers and brilliant points of light reflected from the innumerable tiny frost diamonds that dart to and fro, waver, disappear, and flash into brightness again in the most bewildering manner.

The reservoirs of natural gas were once thought to be inexhaustible. It was even maintained that the gas is produced in the underground laboratories faster than it can be used. This view is not now held. Wells have been exhausted and have ceased to flow, and often the supply from a new one is diminished as soon as another is sunk in its vicinity. However, no community which has once enjoyed the blessings of a gas fuel will willingly return to the use of coal.

Gas has become almost a necessity, and human ingenuity is now at work in a thousand directions to invent methods for producing it cheaply and abundantly from coal or other materials in order that, when the natural supply is exhausted, an equally good artificial supply may take its place. Communities which cannot obtain natural gas are already demanding an artificial product that shall give them equal advantages with localities supplied by nature with this perfect fuel.

Gas stored in portable tanks is being used as fuel beneath the boilers of locomotives and steamboat engines, and indications point to its substitution for coal in the near future on a still wider scale than at present.

KIRK MUNROE.

An Oil-Country Crater.

"It is far grander than an eruption of Vesuvius that I once travelled many miles to see!" exclaimed a lady, as she pointed in awe and admiration at the gigantic cornucopia of coal-black smoke which towered gracefully thousands of feet into the heavens from the top of a burning oil-tank.

Surely few spectacles can compare in grandeur with that afforded by thirty-five thousand barrels of crude petroleum aflame in a mammoth amphitheater of iron; but such a spectacle occurs as often as twice a year in the oil country, in places where large quantities of crude petroleum are stored, and in the case of nearly every such conflagration a flash of lightning causes the outburst.

Storage tanks are constructed of huge sheets of iron riveted together tier upon tier. They resemble gigantic seal-brown cheese-boxes. A roof of wood covered with thin sheets of iron, having a slight upward slant toward the centre, keeps out the storms.

If lightning strikes the tank, the gases which emanate from the oil are ignited, and explode with a loud report. The roof is blown off, and in an instant the great caldron of petroleum has an aureola of marvellous beauty.

If the air is clear and still, the pillar of smoke arises straight toward the heavens like a black waterspout, slowly expanding as its lofty head touches the clouds.

The burning tank is often surrounded by many other tanks, and unless prompt and vigorous action is taken the tank will overflow in a short time; a column of suddenly liberated gases will flash thousands of feet into the heavens for an instant, converting the whole neighborhood into a fiery furnace, and the burning oil will pour over the edges of the tank and sweep the ground in all directions, destroying everything in its pathway, and firing the adjacent tanks.

To guard against such a disastrous overflow, the employés of the owners of the tank work very hard indeed. If the tank is not already surrounded by a deep trench and a high bank of earth, a large force of men, furnished with picks and shovels,

Puncturing the Tank.

hurriedly dig the protecting ditch, piling the earth upon the side more remote from the tank.

Meanwhile, the pumps at the nearest pumping-station are hard at work drawing the oil from the bottom of the burning tank through a pipe, and despatching it elsewhere for storage.

If apparatus for fighting fire is at hand, cooling streams of

water are directed against the red-hot sides of the tank by firemen who lie behind hastily erected shields of wood, through which holes are cut for the passage of the hose-pipe. Meanwhile, horses and men have been despatched for the nearest cannon. The gunners hastily load the brass field-piece, ramming home a solid shot or a great slug of lead. The muzzle of the piece is depressed so that a glance along the barrel strikes the bottom of the great iron caldron, and the bombardment begins.

Again and again the lower tiers of the tank are punctured by the shot, and at each report slender streams of oil and volumes of gas pour forth and burn harmlessly. This action is taken to prevent or delay the dreaded overflow; and the ditch and embankment are intended to check the burning streams of oil in their rush toward the other tanks, if the overflow occurs.

The overflows are regulated by conditions of which engineers have no certain knowledge. Nevertheless, it is believed that the surface of the oil undergoes a constant change while burning, the lighter parts being consumed, and the heavier parts remaining in the form of a dense, heavy scum. Powerful gases generated from the lighter parts below in the great caldron are gradually confined by the thickening of this surface scum, until, steadily accumulating and expanding by reason of the constantly increasing heat above, they force their way irresistibly upward.

These vapors, which rise from ordinary petroleum at as low a temperature as forty-five degrees, are by and by brought into contact with the under surface of the thick scum, which is heated to a temperature of one hundred and fifty degrees, and by reason of this sudden contact they expand with frightful rapidity and power, causing an explosion that forces the thick scum and a flood of light oil over the sides of the tank, and drives every living creature out of the neighborhood.

The puncturing of the sides of the tank allows much of the powerful gas to escape, and the overflow is either prevented or

made less formidable. One of the most dangerous features of an overflow is the fact that, aside from a slight diminution of the heat, the terrible visitation is as unheralded and swift as the lightning flash that fired the crater. Firemen, pipe-line employés and spectators who are anywhere within a thousand feet of the tank flee for their lives when this explosion takes place.

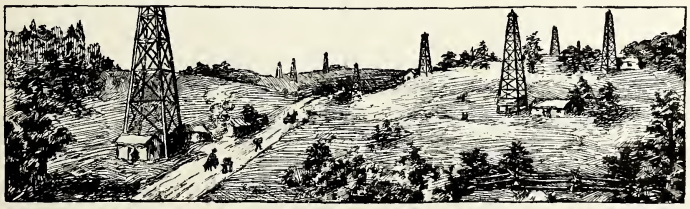
During the overflow of a thirty-five-thousand-barrel tank in the Acme Refinery Yard at Olean, New York, in 1880, leaves upon trees a quarter of a mile distant were shrivelled by the intense heat.

Fortunately the terrible visitation continues but a few seconds. If it lasted long, the destruction of property and loss of life would often reach frightful proportions.

Olean has been for many years the largest storage point for crude petroleum in the world. It is almost encircled by huge iron tanks, each containing thirty-five thousand barrels of oil. There are, I believe, four hundred or five hundred of them, and they dot the hills and unpopulated districts about the town.

To the westward, along the banks of the Allegheny River, lies one of the interesting sights of the oil country, a City of Tanks. At this point the iron receptacles are stationed with geometrical accuracy in long rows, like the houses of a town, and the open spaces between the rows resemble streets.

EARLE H. EATON.



The Mound-Builders.

In the states south of the Great Lakes there are a great many artificial mounds. They differ much in size, some being insignificant mounds a few yards in diameter, while others are huge earthworks, like the one in Ohio called Fort Ancient, the embankments of which extend nearly three miles in a straight line, or like the Cahokia Mound in Illinois, just across the river from St. Louis, which is one hundred feet high and covers about sixteen acres.

The mounds vary as much in shape as they do in size. Some are almost conical, with steep sides; some are oval or rectangular, with gently sloping sides, and some are mere terraces of earth.

Others may be mentioned which are not properly to be classed with mounds at all. They are simply figures in relief of animals and birds, made by banking up the earth in such a way as to form rude outline effigies.

Thus differing, it is evident that the mounds cannot have been erected for one purpose, but that their uses, if not so varied as their size and shape, were at least manifold.

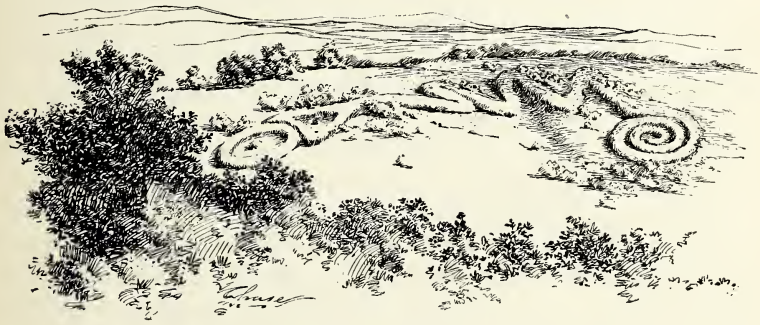
From the earliest times of white settlement, the mounds have been objects of speculation and inquiry, and many conjectures have been made as to their origin and purpose, but for a long time they were enshrouded in mystery.

When questioned as to their origin and use, the Indians are said to have professed utter ignorance. The mounds were in the country when they came, they said; but when and by whom and for what purpose they were made, they did not know. So these ancient monuments came to be regarded as connected with a race different from the Indian, which had previously occupied the country and for some mysterious reason had left it.

Some thought that the builders of the mounds had been

exterminated by the fiercer and more savage Indian tribes; others thought it more probable that they had been driven away to Mexico and Central America, where they were supposed to have become so far civilized as to be able to construct the wonderful temples and houses of that region.

But within recent years another and very different opinion respecting the mounds and their builders has gained ground, until it has nearly supplanted the old one. This is that there is nothing so very mysterious about them after all. As students came to study historical records a little more closely, it was



Serpent Mound in Ohio.

found that not only did certain of the Indian tribes know much about the mounds, but that they were the actual builders of some of them.

Moreover, when some of the mounds were dug into and objects of European manufacture found far beneath the surface, it became evident that these must have been built since Columbus made his mistake and called our aborigines Indians because he supposed he had landed on the shores of India.

At present it is held that many of the mounds were built by the tribes which were found in possession of the country when it was discovered by Columbus, and that the older mounds about which Indian tradition was silent were simply those which were

raised long ago by the ancestors of the present tribes; in short, that all the mounds are Indian mounds, and that to acquire a knowledge of their uses and the meaning of their contents we must study Indian habits and customs. To interpret these habits and customs correctly is to read the riddle of the mounds.

Thanks, then, to the earnest labors of those who have patiently explored the mounds themselves and of others who have diligently studied living tribes and searched into musty historical records, it is now possible to explain the chief motives of those who raised the mounds, as well as the uses of many of the curious implements found therein.

Doubtless much yet remains to be done ere the past can be fully reconstructed, and we can claim to know all the secrets of the Mound-Builders, if indeed so much as this is ever to be hoped for. But, judging from the success of past years, the future is full of promise.

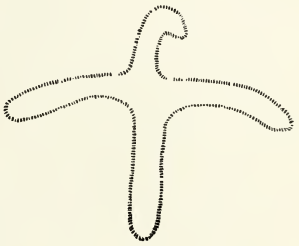
It was soon found that a very large number of mounds were simple burial-places.

While the notions held by our Indians respecting a future state agreed in a general way, there were yet many minor differences. All seem to have believed that the existence of the individual did not cease with death, but that there was another life more or less closely resembling the present one.

According to Indian ideas, the present body was closely connected with this future existence, and all tribes paid great attention to the proper burial of their dead. Many tribes burned the bodies, as did the old Greeks and Romans. Some deposited them upon scaffolds out of the way of wild animals; others laid them carefully away in caves; while still others buried them in the ground.

But whatever their form of burial, all tribes paid particular attention to the care and protection of the bones. It was natural that they should, for the bones are the most imperishable part of the body, and with them is closely connected the idea of a spirit, or soul, as we call it, crude though that notion is in Indian philosophy.

After much ceremony, and doubtless with much lamentation and many tears,— for savages are very demonstrative in their grief,— the body was placed on the ground or upon a terrace of clay. Around it was gathered the property of the deceased, especially those articles which were considered useful in his after life, such as a water-vessel or two, some food, paint for decorating the body, and so on. A fire was then built over the whole, and after it had burned long and fiercely, earth was brought in baskets and heaped over all.



Bird.

Thus the heap of earth above it served two purposes: to protect the remains, and as a monument. Doubtless the richer and more distinguished the deceased, the larger and more imposing the mound.

It was the habit of many tribes to bury their dead in the ground or expose them on scaffolds until the flesh disappeared; and then, perhaps at stated intervals, to gather the bones together and deposit them in an indiscriminate heap. On these occasions their friends sacrificed such objects of value as were most appropriate, or such as would best express their grief and love. Thus the mounds often mark the last resting-place of a group of persons who probably were connected by tribal or kinship ties.

Some tribes buried the bodies outstretched in a horizontal posture; others folded the limbs tightly against the body; and others still wrapped the bones into a compact bundle. Some buried in stone receptacles; others enclosed the body in bark or in rudely woven blankets and clothing.

All of these methods appear in the burial-mounds. Fortunately, when the bodies were cremated, in many cases the fire only half did its work, and many of the objects sacrificed on these occasions have been unearthed, as well as many of the skulls and half-charred bones.

The list of objects taken from the mounds includes everything

dear to the Indian mind. That it was believed the deceased would need his weapons in the next world or on his way there is evident from the numerous arrow and spear heads found. Personal ornaments were deemed essential, and vast numbers of shell beads, pearls, copper trinkets and stone carvings of ceremonial or religious import appear in the mounds.

The Indian was always fond of athletic games as well as those of more questionable morality, such as gambling; and objects used in these games are of frequent occurrence. Everything cherished by the Indian as a protection from the evil and disease spirits, by which the Indian world was peopled, was carefully included, and charms of various sorts are commonly found with the bodies.

Many of the objects found in the mounds, such as the carvings, are finely made, and show much taste on the part of their makers. Before these had been carefully studied, it was assumed that they were finer than anything the Indian produced. This conviction strengthened the opinion that those who made the objects could not have been Indians.

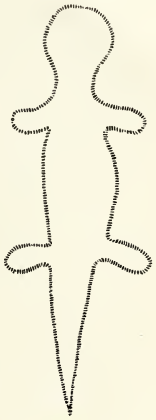
But those who maintained this opinion forgot that the first and inevitable effect upon a savage people of contact with civilization, is to deteriorate their manufactures. The savage, finding the tools of civilization better, gradually ceases to make his own; and as he abandons them, he loses his old skill, and becomes indifferent to beauty and nicety of finish.

When, therefore, the most artistic and best finished objects from the mounds are compared with similar ones made by Indians whose handiwork has not suffered by contact with civilization, Indian art suffers little or nothing by the comparison.

To raise such immense works as the Cahokia Mound must have required great labor, and the size of the mounds has been urged as a reason to suppose that Indians could not have produced them. But it would require no more labor for a comparatively few men and women to throw up a mound in a long time, than for many to build it in a short time; and no

doubt to build such mounds as that of Cahokia must have required many years, perhaps successive generations.

Moreover, the very rude methods employed in mound-building are strikingly suggestive of Indian work. In the case of certain mounds, it has been possible to trace the successive baskets of earth as they were dumped from the shoulders of the dusky carriers.



Otter.

In many places there are embankments of earth in the shape of squares or parallelograms, the appearance of which too closely suggests rude fortifications for their purpose to be mistaken. They were defensive works, places of refuge. Such in fact was Old Fort Ancient, which may have been the work of generations of Indians; and within its ample interior were probably gathered, in times of danger, the tribes that inhabited the neighboring valleys.

Evidences of village sites within its enclosure indicate that in troublesome times villages were established and occupied for considerable periods. Doubtless grounds were prepared for the celebration of such feasts, councils, games and ceremonials as always attended Indian social, religious or tribal proceedings.

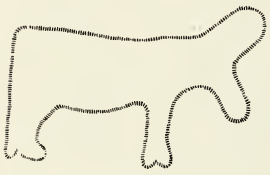
There is another class of mounds of various shapes and sizes, which apparently were the sites of large houses, where dwelt together several families of the same clan, or of council-houses, which were partly for religious and partly for social use.

Most curious of all are the Effigy Mounds in Wisconsin, a group of which, found in Grant County, in that state, are shown in the illustrations. These relief figures of beasts and birds are often made on a gigantic scale, and from the nature of their construction are necessarily so rude that they can rarely be identified as of any particular species, and the attempt to identify them has often resulted in false conclusions.

Thus one mound in Ohio long passed as the effigy of a mastodon or elephant; and as this creature has been supposed to be extinct for a considerable period, the effect of this identification was to bring the existence of the animal down to a very recent date, perhaps to historical times, or else to carry the origin of this particular mound far back into the past.

Now, however, the proboscis of the animal, upon which chiefly rested the theory of its elephantine nature, has been determined to be a slide of earth. So the effigy passes from the list of the marvellous to take its proper but prosaic place in mound history as the figure of a bear.

As to the purpose of erecting these banks of earth in the shape of animals, students appear to be pretty well agreed. Most Indian tribes have myths by which they trace back their origin to certain animals, as bears, otters, snakes and birds.



Bear.

The figures of these supposed ancestors became totem marks, and are tattooed on the persons and pictured on the houses and other property of the Indians. The well-known totem posts of the Haida Indians of Alaska are good examples.

Instead of contenting themselves by carving their totems on their houses, weapons or other property, or painting them on their skins, the Wisconsin tribes adopted a unique plan, and raised on the bosom of Mother Earth their effigy monuments, commemorative of their mythic ancestral beliefs. So inscribed, nature has kindly assisted in their preservation; and though other and more costly monuments crumble away, the effigy mounds live on, mute witnesses of the cherished beliefs of a people whose past history is a cloudland of conjecture.

PROF. H. W. HENSHAW.

Mammoth Cave.

On an interesting occasion I received as a gift a velvet case containing a solid silver key inscribed, "From the Manager and Guides of Mammoth Cave." It was a real key of the iron door at the entrance of the great cave.

Thus it happens that I have the privilege of unlocking the gate of the great cave for myself, and freely exploring its nooks and corners; and by the aid of this key I was able to prepare the map of Mammoth Cave which accompanies this article, and from which a faint idea may be had of its winding mazes.

One day I ventured to go alone into the gloomy caverns. No more peril lurked along the familiar path through the main cave than might have been met in almost any rocky ravine. The powers of darkness may be safely defied by a man armed with lamps, braided oil-rags, plenty of matches, and a coil of magnesium ribbon. Fear was tempered to an agreeable sense of awe.

No pause was made till the Star Chamber was reached, with whose fantastic illusions every visitor to the cave is familiar. These were reproduced as long as I desired, with the discovery that the more intense the artificial light, the brighter the stars seemed to shine in the blue sky overhead.

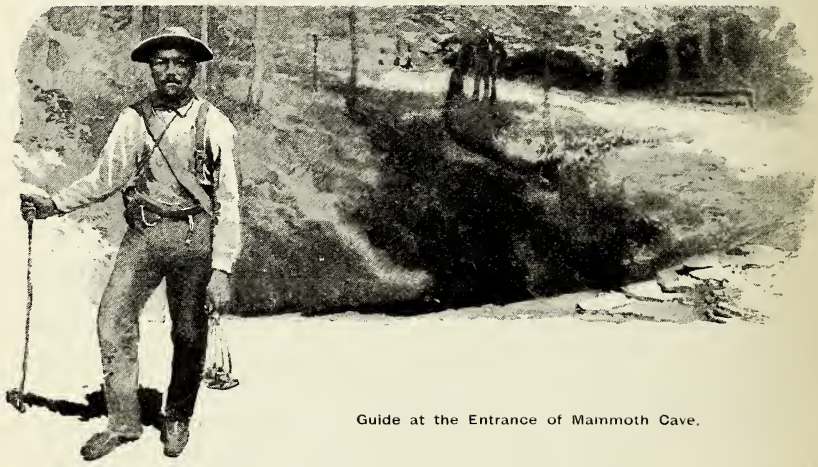
Not one visitor in five hundred advances to the grand portions of the main cave that lie beyond; they all turn back to explore the minor branches. I went on. For a thousand yards there is a succession of noble rooms, strewn with limestone blocks of every size and shape, like the ruins of some old castle of Giant Despair. Here are black chambers, appalling in their funereal gloom.

Turning to the right I approached roaring cataracts that fall from a great height and instantly vanish in a profound abyss. Beyond them arise the walls and pinnacles of the Chief City, once the resort of Indian sagamores and dusky

braves, who left as relics their torches, sandals, arrow-tips and battle-axes.

Here I made an experiment that taxed my nerves; I blew out my lamps. The black darkness seemed to become a palpable and solid thing about me. Sounds were magnified; I heard the cave rats scamper over the rocks and the uncanny bats flutter by. The throbbing of my heart was audible. A whisper or a sigh was mysteriously wafted to the farthest limit of the enormous dome.

The excited fancy conjured up all sorts of illusions in the



Guide at the Entrance of Mammoth Cave.

midnight gloom. Ghosts of the Mound-Builders came hovering round. How thankful I was for the box of matches clutched in my fist, a single one of which had power to put to flight an army of goblins! The match was struck, its tiny blaze was applied to the narrow strip of magnesium tape, the towering crags flashed again into view, and above them swelled the proud arches of the Chief City.

The solitary intruder into this domain of imps and gnomes

was satisfied, and groped his way back safely to the hotel, and the just reprimand awaiting him from the anxious manager.

The regular routes through the cave, one way, do not cover more than twenty miles, while the total length of all known avenues exceeds one hundred and fifty miles. Of the five thousand tourists who annually enter the rocky, moss-grown, vine-clad vestibule, very few wander from the beaten paths which can be comfortably traversed in a day or two.

Almost all visitors hasten past Audubon Avenue, the first right-hand branch from the main cave; yet it equals in grandeur many places over which people go into raptures. It opens from a vast rotunda strewn with pipes, pumps and vats, relics of the saltpetre works of 1812, from which our warlike fathers obtained the means of making gunpowder.

From this avenue miners carted off countless loads of nitrous earth, in doing which they exhumed gigantic skeletons, and had many strange adventures.

If our visit is in winter we are amazed at the myriads of bats that hang, head downward, in broad clusters as dense as swarming bees. They look like sealskin sacks tacked against the ceiling; but when the guide rubs them with his rough hand every tiny mouth flies open, changing the brown robe to a scarlet cushion.

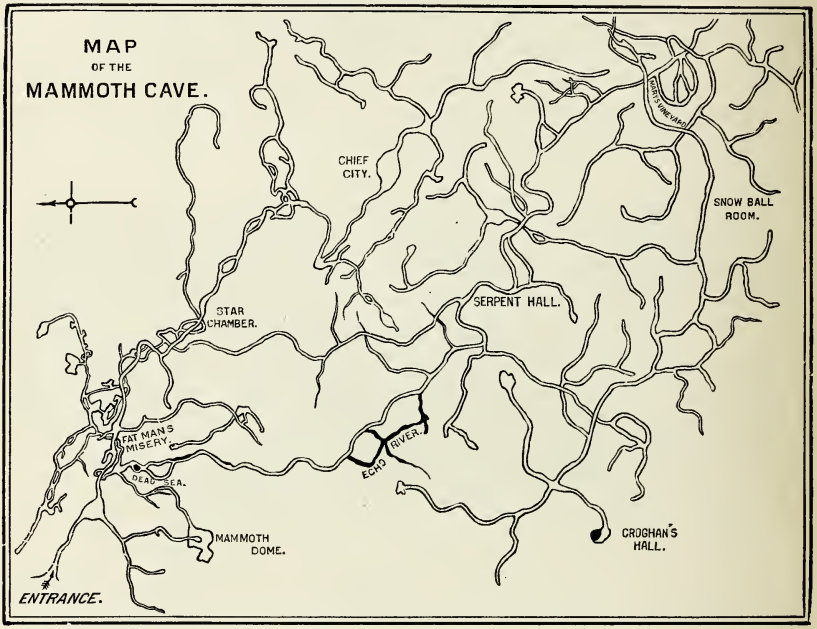
The road is smooth and level. All the rocky slabs are skilfully piled into stone walls. And what are those newly-raked beds, right and left, extending for hundreds of yards under this noble arched way of fifty feet span? We seem to be in a garden many acres in extent, stretching along as far as the eye can reach, even when aided by chemical fires.

This is indeed a garden; it is the Mammoth Cave mushroom farm, on which six thousand dollars were spent under French experts to get it into running order, and whence the manager hopes to supply the markets of our American cities. A shaft for ventilation and irrigation has been sunk from the outside.

That smaller opening from Audubon Avenue leads to the long, winding channel of an ancient torrent, and is called the

Little Bat room. Tread carefully under these low-browed arches, blackened by the torches of the miners. It is a spot from which heedless visitors are wisely excluded.

That ugly black crevice, toward which the floor so treacherously slopes, yawns into a pit down which a reckless miner



once dropped his lamp. A sprightly young negro was lowered to recover it. He returned empty-handed, and having, as it was thought, lost his wits; for he reported having seen a marvellous temple, rivalling the wonders of the Arabian Nights' Entertainments.

But thirty years later that very temple was approached from another direction; at one end of it is a cataract a hundred feet

or more in height, while at the other end rise pillars eighty feet high. And on the floor lay the rusty old lamp!

Surprises continually await cave-hunters. Guides plodding homeward one day from Croghan's Hall, the extreme end of the Long Route, were astonished to see a volume of smoke issue from a crevice in the Serpent Hall. They fled hastily across Echo River. There they found workmen pitching a boat and making a great smoke.

This gave them a hint that an undiscovered passage existed between the Serpent Hall and the main cave. The reader will find it indicated on the map; but its true crookedness could not be drawn on so small a scale.

In company with two guides, I completed a survey of Ganter Avenue, as we call this passage. At first the guides thought it to be about four miles long, and it certainly seems so. But it is really eighty-five hundred feet in length, and probably makes a twist as often as once in twenty feet.

It is a combination of three different avenues, on as many different levels. The connection between them is made by a stairway of one hundred solid stone steps, which we named Rider Haggard's Flight, in honor of the author of King Solomon's Mines. The avenue was originally from forty to sixty feet high, and from six inches to ten feet wide.

By assiduous labor Mr. Ganter, the manager, had a stone floor laid midway of the avenue where the crevice widens. The pick and blast were used wherever needed, so that now any one who wishes to do so can thread the entire passage easily.

Its main advantage is that it affords a safe exit from the regions beyond the rivers, in case of an overflow. But even yet portions of Ganter Avenue are so narrow that if two persons meet, one must lie down and let the other walk over him.

"What is there beyond that rocky ledge?" said I to one of the guides, as we stood in River Hall. He replied that he did not know, but would like to find out.

We found a wide, low avenue in which no footprints were visible. Soon we had to go on our hands and knees, crawling through the finest, cleanest yellow sand. It was plainly the dry bed of an ancient river. For half an hour we pursued our toilsome way, till suddenly we came out into Pensico Avenue.

I remained awhile at the Bottomless Pit, amusing myself by throwing fire-balls into it. Being saturated with oil, the balls floated to and fro on the water and lighted up the walls of the chasm grandly. Such chasms are styled pits or domes, according to the point of view. They cut through all the levels of the cavern.

The sandy way by which we had come was one of the higher and more ancient channels by which this subterranean region was formerly drained. The tortuous passage called Fat Man's Misery drained it at a later era. Still lower channels were subsequently found, one opening midway into the pits, and another draining them from the very bottom.

One of the guides made his way through this lowest passage, and found that half a dozen of the pits were united into one vast room which, by special permission of the President, we named Harrison's Hall.

While trying to measure a pit not visited before, a ponderous rock was dislodged just above me, and whirling by so close as to graze my shins, fell more than a hundred feet with a crash into the abyss. Other fragments followed it until the cavernous echoes awakened were like a volley of thunder.

Speaking of echoes, let us take a ride on Echo River before leaving the cave. It is worth a trip from Boston to Kentucky, merely to float for an hour on those magical waters. The phenomena have been frequently described; but most visitors

are so in love with their own voices as to miss the finest effects of all.

The guide rows us to exactly the right spot in this long and deep underground river. Here the rocky arches meet the water vertically, and without a shore; but the waves lap musically into a thousand little cavities as we row along.

This is only the gentle prelude. For now, while uttering certain peculiarly mellow vocal sounds harmonizing with the keynote of the passageway, the guide rocks the boat to and fro, so that we must hold to the gunwales to keep from being thrown overboard. And then begins a concert that, if not interrupted, may last fully half an hour.

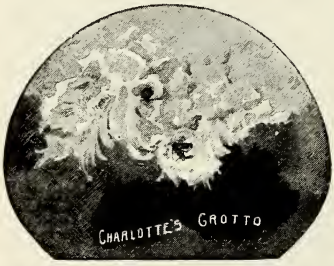
First comes a sound like the tinkling of silver bells. Larger, heavier bells take up the melody, as the billows caused

by the rocking of the boat strike the cavities in the wall. Then it seems as if the chimes of many cathedrals had conspired to raise in this strange place a tempest of sweet sounds.

The music dies away, and ghostly mutterings ensue. Many voices seem to whisper, chatter and cry. They laugh, as if in glee, and anon shriek as if in agony. Then all is silent. We are about to speak, when the guide makes a sign to keep

still; and we sit in curious expectation. Lo! as if from some deep recess hitherto forgotten, comes a tone tender and profound; after which, like gentle memories, the mellow sounds that had been heard before awake again, until River Hall rings anew with the wondrous harmony.

Amid the alabaster flowers of Mammoth Cave the fancy finds the mimicry of every blossom, from the modest daisy to the flaunting sunflower. The floral avenues open to the public have been marred by covetous or careless visitors. A rumor had reached me of a secluded chamber, known as Charlotte's Grotto, where the wildest flower dream of the cave-hunter would be realized.



On hearing a comely colored matron accosted as Aunt Charlotte, I asked her if she knew of the grotto, on the venture that it derived its name from her.

"Law, yes, chile!" said she; "that grotto's named for me. My poor dead husband found it and gave it my name. I reckon one of my boys can take you to it."

Her reckoning was not amiss. I was taken to it; and there I found what seemed to be fringes of the night-blooming cereus, clumps of lilies, spikes of tuberoses, drooping fuchsias, wax-leaved magnolias, every gem of the greenhouse and parterre; only the snowy plumes were all of spotless alabaster.

H. C. Hovey.

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